City of Redmond

ON-SITE STORMWATER MANAGEMENT BUSINESS CASE ANALYSIS

FINAL REPORT

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Section I. EXECUTIVE SUMMARY

The Western Washington Phase II Municipal Stormwater Permit requires development to manage stormwater runoff on-site, where feasible. When this new stormwater requirement was initiated, Redmond City Council directed staff to study the impact of this new requirement to development in Downtown and Overlake. Both neighborhoods are designated regional growth centers and are planned to accommodate dense urban development to meet the City's growth targets.

To accomplish this, the City conducted a Business Case Analysis comparing different levels of on-site stormwater management for new development and redevelopment in the Downtown and Overlake areas. This Business Case Analysis is a goal-oriented, transparent, and repeatable process that best links City goals to tangible policy decisions. The process has four main parts, discussed in further detail below.

Identifying Goals.

The study goals link directly back to the City's objectives and acknowledge social, economic, and environment considerations. These include:

- ***Goal #1: Protect human health and safety by managing system capacity and well water supply***
- ***Goal #2: Help meet development goals for Overlake and Downtown through cost effective, predictable, permit compliant regulations***
- ***Goal #3: Maintain or increase environmental protection through stormwater management***

Determining Viable Alternatives.

With these goals in mind, staff developed four viable analytical scenarios for consideration in the Business Case Analysis:

- **No Infiltration:** Developments in the Downtown and Overlake areas determine that roof infiltration is infeasible and do not infiltrate any stormwater from their roofs. This would result in all stormwater runoff entering the public stormwater conveyance system. This scenario reflects a lower level of roof infiltration than has occurred with new development prior to the new Ecology standards.

- **100% Infiltration at Half of Sites:** Half of the developments in Downtown and Overlake with good soils infiltrate all of the runoff generated by their roofs. The other half determines that stormwater infiltration is infeasible. This scenario is most similar to the state of stormwater infiltration in new developments as occurred prior to the new 2017 Ecology standards.

- **91% Infiltration:** Developments with good soils in Downtown and Overlake implement cost-effective on-site stormwater management, infiltrating 91% of the runoff generated by their roofs.

- **100% Infiltration:** All development with good soils in Downtown and Overlake infiltrate all of the stormwater runoff generated by their roofs. This results in the least amount of stormwater entering the City's stormwater conveyance system.

Establishing Evaluation Criteria.

The project team developed the following criteria to provide the basis for differentiating and evaluating the scenarios described above. All criteria relate directly back to a goal.

- **Well Shut-Off Potential Increase (Goal #1):** The City relies on wells located in the Downtown area to help meet its water supply needs. A reduction in on-site infiltration would negatively impact these wells, as there would be less groundwater to recharge them.

- **Regional Flow Control & Flood Protection (Goal #1):** The City's stormwater conveyance system must have adequate capacity to convey runoff to regional facilities. Less on-site stormwater management results in more runoff to convey, increasing flooding frequency and requiring greater capital investments in conveyance capacity.

- **Private Infiltration System Costs (Goal #2):** Infiltration of roof runoff requires the construction and ongoing maintenance of a private infiltration facility. Attaining higher levels of infiltration requires additional capital investments and results in increased maintenance costs.

- **Change in Market Value (Goal #2):** The need for on-site infiltration facilities can restrict the size and type of development that occurs on a specific site, potentially impacting the market value of that site.

- **Sammamish River Temperature (Goal #3):** Because it impacts groundwater levels (which are cooler than water coming from surface streets), stormwater infiltration can influence stream temperatures.

- **Stream Water Quality (Goal #3):** Stormwater runoff carries pollutants that negatively impact the environment – as a result, reducing the level of untreated runoff reduces the amount of pollution in local streams. This study includes measured copper loadings in the Redmond Way basin based on flow rates.

- **Regional Runoff Treatment Costs (Goal #3):** The cost of regional stormwater treatment increases with the volume of runoff being treated. On-site roof infiltration reduces the volume of stormwater runoff requiring treatment, resulting in cost savings.

Analyzing Options.

Staff measured how each scenario differs in the established criteria, resulting in a relative ranking of scenarios. This ranking is further broken down by lifecycle cost as well as individual criteria.

	No Infiltration	100% Infiltration @ ½ the Sites	91% Infiltration	100% Infiltration	Relative Impact
Overall Analysis Ranking	4th	2nd	3rd	1st	
Lifecycle Costs ($ Millions)	$153	$128	$137	$98	
Individual Criteria Rankings:					
Reg. Flow Control & Flood Protection	*4th*	*2nd*	*3rd*	*1st*	*High*
Regional Runoff Treatment Costs	*4th*	*3rd*	*2nd*	*1st*	*High*
Private Infiltration System Costs	*1st*	*2nd*	*3rd*	*4th*	*Low*
Change in Market Value	*1st*	*3rd*	*2nd*	*4th*	*Low*
Stream Water Quality	*4th*	*3rd*	*2nd*	*1st*	*Very Low*
Well Shut-Off Potential Increase[1]	*2nd*	*N/A*	*N/A*	*1st*	*Very Low*
Sammamish River Temperature	*2nd*	*N/A*	*N/A*	*1st*	*Very Low*

The City evaluated additional criteria. One example is the ancillary benefits of green infrastructure. This analysis focused on roof infiltration that does not have ancillary benefits like rain gardens and green roofs. In Overlake, green infrastructure will collocate in required landscaped areas.

[1] Scenarios with "N/A" were not studied further because results for first and second ranked scenarios were similar.

Under its NPDES permit, the City must require on-site stormwater management using specific measures where feasible. The results of this analysis show that a future scenario where 100% of new development and redevelopment infiltrate 100% of roof runoff in the Downtown and Overlake provides the greatest benefit to the City of Redmond. The City can realize these benefits through a combination of monitoring and policy that reduces uncertainty around on-site infiltration feasibility and encourages its development and maintenance.

Section II. INTRODUCTION

The City of Redmond (City) holds a National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Stormwater Permit for Western Washington, which permits the City to discharge stormwater into State waters and requires the City to create and implement a Stormwater Management Program (SWMP).

As part of this program, the City must regulate the stormwater impacts of new development and redevelopment. Specifically, Minimum Requirement #5 in the Stormwater Management Manual for Western Washington requires new development and redevelopment to provide on-site stormwater management using specific measure to infiltrate roof runoff and other impervious areas where feasible[2]. Feasibility is a critical part of this requirement, as the extent to which on-site stormwater management is feasible is hard to predict.

This uncertainty complicates infrastructure planning and business development, as the City needs to understand the level of expected on-site stormwater management to adequately plan for City services. In both Overlake and Downtown, stormwater regional facilities are built or designed to treat runoff (Downtown) or control runoff (Overlake). The regional facilities have been designed with an assumed amount of infiltration occurring. The new requirement of development to have on-site stormwater management impacts the planning and assumptions of regional facilities in the urban centers.

Through policies and monitoring, the City can reduce uncertainty and better plan for future development. However, the City must determine the best level of on-site stormwater management it should manage towards (while still meeting permit requirements). To analyze this issue, the project team prepared a Business Case Analysis (BCA) that considers various on-site stormwater management scenarios for the Downtown and Overlake areas. The BCA helps determine which scenario best achieves the City's goals at the lowest cost while meeting permit requirements.

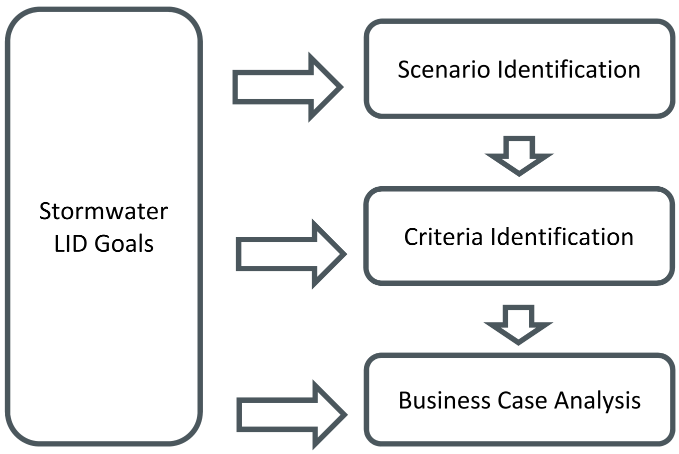
[2] Appendix I – Minimum Technical Requirements of the *Western Washington Phase II Municipal Stormwater Permit*. Last updated 16 Jan 2015. P. 20

It is important to recognize the diligence of City staff in preparing this analysis. Their work is a service to City residents, businesses, and the development community, in helping meet Redmond's goals.

Section III. BCA PROCESS

The Business Case Analysis (BCA) process involves four steps, summarized below in **Figure III-1:**

Figure III-1: Business Case Analysis Process



The process depicted in **Figure III-1** intends to align the City's decision-making with its goals in a transparent and repeatable manner. It involves establishing goals, developing plausible alternatives and evaluation criteria, and preparing the calculations for each alternative. Throughout the process, City staff engaged with an external stakeholder group to confirm and amend the findings of this analysis. City staff would like to thank this stakeholder group for their valuable contributions to this effort.

III.A. GOAL SETTING

The City established goals for this BCA with two primary focuses;

- First, the goals should link back to the City's mission, vision, and values.
- Next, the goals should be specific enough to relate directly to the issue being addressed.

City staff developed a set of goals over two meetings and later confirmed them with the stakeholder group. The first meeting was a fact-finding workshop introducing the issue and discussing goals; the second meeting involved refining the goals. The resulting goals are as follows:

- ***Goal #1: Protect human health and safety by managing system capacity and well water supply***
- ***Goal #2: Help meet development goals for Overlake and Downtown through cost effective, predictable, permit compliant regulations***
- ***Goal #3: Maintain or increase environmental protection through stormwater management***

These goals align with a traditional triple-bottom-line analysis that considers the social (Goal #1), economic (Goal #2), and environmental (Goal #3) impacts of a decision.

III.B. SCENARIO DEVELOPMENT

The BCA involved evaluating a variety of scenarios representing unique decision points available to the City. Given the realm of possibilities, defining alternatives can be a daunting process – however, limiting the number of scenarios is important for the sake of practicality in preparing calculations, assessing results, and communicating findings. Recognizing this, City staff established requirements that all scenarios:

- ***Comply with applicable regulations, including State laws and development regulations.*** No scenario can outwardly go against any established regulations, as the City would not choose an alternative that is against the law.
- ***Establish consistent standards for the Overlake and Downtown areas.*** It is important that the methods used in the analysis are consistent for both areas in order to prevent conflicting or variant policies.
- ***Comply with the agreed upon use of regional facilities.*** Since the City has invested heavily in regional stormwater facilities, it would not choose an alternative that violates the accepted use of these facilities.
- ***Align with the City's mission, vision, and values.*** This constraint prevents consideration of options that are outwardly against City interests. For example, preventing all development in the Downtown and Overlake areas would go against the City's established strategic objectives and cannot be considered in the analysis.

The City also defined a set of variables to differentiate among the various scenarios considered. These variables include development requirements, in-lieu compliance opportunities, location of on-site stormwater management facilities, and amount of on-site stormwater management. Ultimately, the City decided that only the amount of on-site stormwater management should vary between scenarios – other changes either violated previously determined constraints or were physically infeasible by site constraints.

Resulting Scenarios

Staff originally brainstormed seven potential scenarios for analysis. After analyzing constraints and variables, the City determined that four full build out scenarios were truly viable:

- **No Infiltration:** Developments in the Downtown and Overlake areas determine that roof infiltration is infeasible and do not infiltrate any stormwater from their roofs. This would result in all roof stormwater runoff entering the public stormwater conveyance system. This scenario reflects a lower level of roof infiltration than has occurred with new developments prior to the new Ecology standards.

- **100% Infiltration at Half of Sites:** Half of the developments with good soils infiltrate all of the runoff generated by their roofs. The other half determines that stormwater infiltration is infeasible. This scenario is most similar to the state of stormwater infiltration in new developments as occurred prior to the new Ecology standards.

- **91% Infiltration:** Developments with good soils implement cost-effective on-site mitigation measures, infiltrating 91% of the annual runoff generated by their roofs.

- **100% Infiltration:** All development with good soils in the Downtown and Overlake study areas infiltrate all of the stormwater runoff generated by their roofs. This results in the least amount of stormwater entering the conveyance system.

III.C. CRITERIA AND MEASUREMENT

The criteria provide a basis for evaluating and comparing scenarios, helping City staff determine the optimal alternative. The selection process utilized three guidelines to ensure that each criterion contributes meaningfully to the decision making process.

- ***Relate directly to goals of the study.*** The criteria should help show how a specific scenario helps or hinders achievement of the goals established at the beginning of the study. All criteria should have a direct impact on goals.

- ***Vary by scenario.*** Even if a specific metric is deemed important, it does not facilitate an evaluation and ranking of scenarios if it has the same value for all scenarios. For example, traffic safety may be very important to the City but it is unlikely that car accidents will vary based on the roof runoff infiltration of new development.

- ***Be unique and mutually exclusive with other criteria.*** Criteria should not overlap, as overlapping criteria can introduce bias to the comparison of scenarios by placing excessive emphasis on a particular impact.

Of these considerations, the main driver for criteria selection in this BCA dealt with variation between scenarios. Some criteria initially deemed as important would later be shown to not vary between each scenario. From an initial criteria list of 17, seven were used for the analysis:

- **Well Shut-Off Potential Increase (Goal #1):** The City relies on wells located in the Downtown area to meet its water supply needs. A reduction in on-site stormwater management would negatively impact the City's supply wells, as there would be less groundwater to pump.

- **Regional Flow Control & Flood Protection (Goal #1):** The City's stormwater conveyance system must have adequate capacity to convey runoff to regional facilities. Less on-site stormwater management results in more runoff to convey, increasing flooding frequency and requiring greater capital investments in conveyance capacity.

- **Private Infiltration System Costs (Goal #2):** Infiltration of roof runoff requires the construction and ongoing maintenance of private infiltration facilities. Attaining higher levels of infiltration requires additional capital investments and results in increased maintenance costs.

- **Change in Market Value (Goal #2):** The need for on-site stormwater management facilities can restrict the size and type of development that occurs on a specific site, potentially impacting the market value of that site by reducing the buildable area.

- **Sammamish River Temperature (Goal #3):** Groundwater is cooler than surface waters during summer months. Increasing groundwater through on-site stormwater management can increase groundwater entering the Sammamish River, cooling the river.

- **Stream Water Quality (Goal #3):** Stormwater runoff carries pollutants that negatively impact the environment – as a result, reducing the quantity of runoff reduces the amount of pollution in local streams.

- **Regional Runoff Treatment Costs (Goal #3):** The cost of regional stormwater treatment facilities increases with the volume of runoff being treated. On-site mitigation reduces the volume of runoff requiring treatment, resulting in cost savings.

Each criterion must also have a method for measurement that can easily be compared among future build out scenarios. There are three types considered in this analysis:

- **Basic Scaling Factor**. This is a basic ranking scale, such as 1 – 5 or High/Medium/Low. It is the simplest measurement technique and useful for criteria that are difficult to measure. It is also useful for comparing multiple, very different, criteria.
- **Cost Equivalent**. This involves a dollars-to-dollars comparison where impacts are measured in terms of cost.
- **Physical Measurement**. This drills down to a specific measurable quantity such as gallons infiltrated, pounds of metals removed, etc. This is more complicated than a scaling factor and useful when criteria cannot easily be converted to cost-equivalent impacts.

In a BCA with many alternatives or ranking requirements, it is useful to standardize the measurement options and, as necessary, weight these options by importance. While this is good for a high-level "apples-to-apples" comparison, it risks assuming a false level of accuracy. With only four scenarios, such standardization is not necessary. Instead, the most accurate measurement option is used for each criterion. These are shown below.

Table III-1: Criteria Descriptions

Criteria	Measurement Option	Description
Well Shut-Off Potential Increase	Physical Measurement	Change (in inches) of groundwater levels around wells due to changes in infiltration
Regional Flow Control and Flood Protection	Cost Equivalent	Cost required to adequately size pipes and facilities
Private Infiltration System Costs	Cost Equivalent	Cost for building and maintaining private infiltration facilities
Change in Market Value	Cost Equivalent	Change in value (measured in dollars) of a property due to development alterations related to infiltration
Regional Runoff Treatment Costs	Cost Equivalent	Estimated cost for treating additional stormwater for roof runoff
Sammamish River Temperature	Physical Measurement	The change in the predicted temperature of the Sammamish river
Stream Water Quality	Physical Measurement	Amount of copper loading into the Redmond Way basin in kilograms

Section IV. BCA RESULTS

The BCA helps individuals make a cost-effective decision that best reflects established goals. It is a transparent, repeatable, decision-support tool. As a support tool, the BCA does not certify the *best* decision but rather informs the decision-making process. It helps the user understand which decisions best relate to his or her goals in relation to expected costs. The analysis is conducted in two parts:

- The first step involves measuring criteria for each scenario through a series of technical analyses, the results of which are shown in **Appendix A**. **Appendix B** shows additional cost calculations that convert results from the technical analysis to comparable costs across scenarios. This analysis considers lifecycle costs over a 30-year time horizon. It also includes the calculation methodology of the potential market loss resulting from on-site stormwater management.

- The second step involves combining and rating the criteria for each alternative to produce a relative ranking of the scenarios.

The result of this analysis is a ranking of each criteria, for each scenario. Staff analysis showed that, for some criteria, changes between scenarios were small or non-existent – while some scenarios ranked higher in these criteria, the relative impact is small.

Dollar costs are summed together to produce a lifecycle cost estimate for each scenario. This total lifecycle cost, in conjunction with the remaining criteria, provide for an overall ranking of each scenario. These three items (overall ranking, lifecycle cost ranking, and individual criteria ranking) are shown below. **Appendix C** shows the detailed analysis for each scenario.

IV.A. RESULTS

Table IV-1: Business Case Analysis Results

	No Infiltration	100% Infiltration @ ½ the Sites	91% Infiltration	100% Infiltration	Relative Impact
Overall Analysis Ranking	4th	2nd	3rd	1st	
Lifecycle Costs ($ Millions)	$153	$128	$137	$98	
Individual Criteria Rankings:					
Reg. Flow Control & Flood Protection	*4th*	*2nd*	*3rd*	*1st*	*High*
Regional Runoff Treatment Costs	*4th*	*3rd*	*2nd*	*1st*	*High*
Private Infiltration System Costs	*1st*	*2nd*	*3rd*	*4th*	*Low*
Change in Market Value	*1st*	*3rd*	*2nd*	*4th*	*Low*
Stream Water Quality	*4th*	*3rd*	*2nd*	*1st*	*Very Low*
Well Shut-Off Potential Increase[3]	*2nd*	*N/A*	*N/A*	*1st*	*Very Low*
Sammamish River Temperature	*2nd*	*N/A*	*N/A*	*1st*	*Very Low*

IV.B. DISCUSSION OF RESULTS

The overall ranking is determined considering all criteria and their relative impacts. The "100% Infiltration" scenario ranks first (most preferred) due to its lower lifecycle cost and overall top ranking in other criteria such as water quality. The "No Infiltration" scenario ranks lowest due to the significant increase in infrastructure costs related to conveying additional stormwater. It's important to note that the costs provided do not include the cost of already built stormwater regional facilities. The costs provided are in addition to investments already made.

[3] Scenarios with "N/A" were not studied further because results for first and second ranked scenarios were similar.

Significance of high-volume flows

A main cost-driver for each scenario dealt with capital costs for conveying and treating stormwater runoff, mainly making sure the system can handle higher-volume storms. These infrequent, but larger, storm events drive up infrastructure costs and result in a relatively lower cost for the “100% Infiltration” scenario. This issue is particularly apparent in the “91% Infiltration” scenario – even though this scenario calls for 91% infiltration on-site, such a design does not reduce the size of conveyance needed to limit flooding.

Relative market value impact

Staff analysis of on-site infiltration potential resulted in a finding that the majority of existing sites, if following current land use codes, can implement 100% on-site infiltration without changing the nature of construction. This means that the relative market cost of private infiltration facilities is significantly lower than originally anticipated in this study. Such a finding drives relative costs in the “100% Infiltration” scenario down.

Stream and groundwater impacts are relatively low

Metals loading, river temperature, and well shut-off potential, while different among scenarios, were found to change little. This relatively low impact is a result of the role roof infiltration plays in recharging groundwater and providing flows to the Sammamish River relative to other inputs. Inputs are low enough that while there is a measurable variance between scenarios, there is not significant impact to groundwater levels or river water quality. Thus while the “100% Infiltration” scenario ranks first in water quality, it is not a major driver in its overall ranking.

It is important to note that if water quality, groundwater recharge, or river temperatures were studied for the entire area that influences each criterion the result of on-site stormwater management would not be insignificant. The study area is a fraction of the overall area influencing each criteria.

Additional green infrastructure benefits are not measurable

Although the benefits of green infrastructure are well-recorded[4], further analysis showed that they do not apply to this BCA due to the type of infiltration facilities being considered. Thus while these benefits were part of the initial list of 17 criteria, they were not included in the final calculation.

[4] For example, see compilation provided by the Center for Neighborhood Technology here <http://www.cnt.org/sites/default/files/publications/CNT_Value-of-Green-Infrastructure.pdf> (accessed 21 August 2017).

Outside of the water quality benefits already defined, green infrastructure is shown to provide additional benefits due to the utilization of plants and green space created in some instances. In the Downtown area, on-site stormwater management will be accomplished underground (drywells, trenches) rather than the types of on-site stormwater management with plants and green space that provide ancillary benefits. Green infrastructure may be used in the Overlake area, but it is not clear if or how green infrastructure would provide ancillary benefits in comparison to typical landscaping. There is therefore no measureable impact. Although the “100% Infiltration” scenario ranks highest in the analysis overall, ancillary green infrastructure benefits do not play a major role in that ranking.

Section V. Conclusion

This On-site Stormwater Management Business Case Analysis relates the City of Redmond's goals to roof infiltration alternatives in the Downtown and Overlake urban centers.

The process identifies the 100% roof runoff infiltration scenario as the cost-effective solution that best matches City goals. This means that the City will benefit overall if future development infiltrates roof runoff. The City should consider these results when establishing policies and procedures to better define the feasibility of infiltrating roof runoff.

To realize the benefits described in this Business Case Analysis, it will be important for the City to provide a level of certainty with regard to the amount of roof runoff infiltration expected. This can come from a combination of monitoring, incentives, and prescriptive policy measures. Although the "100% Infiltration" scenario ranks highest overall, its benefits will not be realized if the City must oversize regional facilities due to uncertainty.

Appendix A: Technical Memorandum

APPENDIX B: COST MODEL

The cost model derives all values from the technical analyses described in Appendix A. Additional economic assumptions (including interest rate and analysis life cycle) are within the cost model. The cost model is an Excel file included with this report.

Potential market value loss does not have a separate technical memo in Appendix A, but is calculated in the cost model. This metric is derived using the development size analysis shown in the technical memos. It uses property values procured from the King County Assessor's Office as the basis for potential market value loss. Properties used as the baseline are chosen by their location (within the potential market loss area) and timeliness of development (only new developments were chosen to reflect the potential higher market value of new projects).

Market loss is calculated using potential site size restrictions that may reduce building size as shown in the technical memos. These estimates are conservative assumptions. Potential building size reduction for each site equates to the full equivalent market loss of that amount of property. In reality, market loss will not be this high. However, without knowledge of actual future development this serves as a conservative estimate and is applicable in this analysis due to the small relative impact of this metric.

APPENDIX C: DETAILED SCENARIO RESULTS

No Infiltration Scenario

Under this scenario all development in the Downtown and Overlake regions do not infiltrate any stormwater from building roofs. This means that all stormwater generated by roofs flows into the stormwater conveyance system.

Total Anticipated Lifecycle Cost: $153 million

Life Cycle Cost Ranking: Fourth

Detailed Overview of Benefits and Costs

Goal 1: Protect human health and safety by managing system capacity and well water supply

	Effect	Measureable Impact	Ranking
Well shut-off potential increase	Up to 1.8 inches reduced groundwater levels	No current measurable impact	Second
Regional flow control and flood protection	No infiltration will require the highest capital investment in conveyance, flow control, and runoff treatment.	$114 million	Fourth

Goal 2: Help meet development goals for Overlake and Downtown through cost effective, predictable, permit compliant regulations

	Effect	Measureable Impact	Ranking
Private infiltration system costs (capital & O&M)	With no on-site infiltration, there are no additional costs	$0	First
Change in market value	No onsite infiltration means no potential reduction in building or parking size	$0	First

Goal 3: Maintain or increase environmental protection through stormwater management

	Effect	Measureable Impact	Ranking
Sammamish Stream Temp	Less groundwater flow, higher water temps reaching the river from Downtown	No measurable impact	Second
Stream Water Quality (Metals)	3.49 kg annual copper loading from Redmond Way basin	No measurable impact	Fourth
Regional Stormwater Runoff Treatment Costs (Capital & O&M)	More stormwater treatment leads to higher capital and operations costs	$39 million in costs	Fourth

100% Infiltration at ½ the Sites Scenario

Under this scenario, it is assumed that 50% of developments with good soils infiltrate 100% of stormwater runoff generated by roofs. This means that 50% of all sites with good soils would consider stormwater infiltration infeasible. This scenario is most similar to the state of stormwater infiltration in new developments as occurred prior to the new Ecology standards.

Total Anticipated Lifecycle Cost: $128 million

Life Cycle Cost Ranking: Second

Detailed Overview of Benefits and Costs

Goal 1: Protect human health and safety by managing system capacity and well water supply

	Effect	Measureable Impact	Ranking
Well shut-off potential increase	Groundwater levels assumed not to change from current	No measurable impact	N/A
Regional flow control and flood protection	100% infiltration at ½ the sites reduces large storm impact and reduces capital costs for conveyance and flow control.	$82 million	Second

Goal 2: Help meet development goals for Overlake and Downtown through cost effective, predictable, permit compliant regulations

	Effect	Measureable Impact	Ranking
Private infiltration system costs (capital & O&M)	Larger facilities cost more but are only on 50% of sites. Maintenance costs do not vary significantly by size	$10 million	Third
Change in market value	Only 1.5% of sites potentially impacted through reduced building site size	$4 million	Second

Goal 3: Maintain or increase environmental protection through stormwater management

	Effect	Measureable Impact	Ranking
Sammamish Stream Temp	Minimal measurable effect	No measurable impact	N/A
Stream Water Quality (Metals)	3.13 kg annual copper loading from Redmond Way basin	No measurable impact	Third
Regional Stormwater Runoff Treatment Costs (Capital & O&M)	50% of stormwater infiltration still requires regional treatment investment	$32 million	Third

91% Infiltration Scenario

This scenario considers a cost-effective on-site infiltration option where 100% of sites with good soils infiltrate only 91% of stormwater runoff generated by roofs. 91% infiltration results in lower on-site costs due to the smaller size of the facilities.

Total Anticipated Lifecycle Cost: $137 million

Life Cycle Cost Ranking: Third

Detailed Overview of Benefits and Costs

Goal 1: Protect human health and safety by managing system capacity and well water supply

	Effect	Measureable Impact	Ranking
Well shut-off potential increase	Between zero and 4 inches increase in groundwater levels assumed	No measurable impact	N/A
Regional flow control and flood protection	91% infiltration does not assist in conveying large storms meaning higher capital requirements for conveyance upsizing.	$102 million	Third

Goal 2: Help meet development goals for Overlake and Downtown through cost effective, predictable, permit compliant regulations

	Effect	Measureable Impact	Ranking
Private infiltration system costs (capital & O&M)	Smaller facilities lower costs but additional sites increase maintenance costs	$8 million	Second
Change in market value	Only 3% of sites potentially impacted but with smaller facility sizes	$2 million	Second

Goal 3: Maintain or increase environmental protection through stormwater management

	Effect	Measureable Impact	Ranking
Sammamish Stream Temp	Minimal measurable effect	No measurable impact	N/A
Stream Water Quality (Metals)	2.84 kg annual copper loading from Redmond Way basin	No measurable impact	Second
Regional Stormwater Runoff Treatment Costs (Capital & O&M)	Slightly lower capital and operations requirements due to infiltration from sites	$25 million	Second

100% Infiltration Scenario

Under this scenario, all development with good soils in the Downtown and Overlake regions infiltrate 100% of stormwater runoff generated by roofs. This results in the least amount of stormwater entering the conveyance system.

Total Anticipated Lifecycle Cost: $98 million

Life Cycle Cost Ranking: First

Detailed Overview of Benefits and Costs

Goal 1: Protect human health and safety by managing system capacity and well water supply

	Effect	Measureable Impact	Ranking
Well shut-off potential increase	Up 4 inches increase in groundwater levels	No measurable impact	First
Regional flow control and flood protection	Greatest infiltration levels lowers regional flow control requirements and conveyance upsizing needs, minimizing capital costs	$49 million	First

Goal 2: Help meet development goals for Overlake and Downtown through cost effective, predictable, permit compliant regulations

	Effect	Measureable Impact	Ranking
Private infiltration system costs (capital & O&M)	Larger facilities on 100% of sites mean the highest maintenance and capital costs	$19 million	Fourth
Change in market value	Only 3% of sites feasibly impacted through potentially smaller building footprints	$8 million	Fourth

Goal 3: Maintain or increase environmental protection through stormwater management

	Effect	Measureable Impact	Ranking
Sammamish Stream Temp	Slightly lower temperatures reaching Sammamish due to increased groundwater flows	No measurable impact	N/A
Stream Water Quality (Metals)	2.77 kg annual copper loading from Redmond Way basin	No measurable impact	First
Regional Stormwater Runoff Treatment and Detention Costs (Capital & O&M)	High levels of infiltration leads to lower treatment costs	$21 million	First